MISSOURI DEPARTMENT OF NATURAL RESOURCES
AIR AND LAND PROTECTION DIVISION
ENVIRONMENTAL SERVICES PROGRAM
Standard Operating Procedures

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SOP TITLE: Collection of Samples from Wells

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SUMMARY OF REVISIONS: Section 6.3.4 on handling purge water was modified.

APPLICABILITY: The procedures established in this SOP apply to all ESP staff who may be responsible for collecting groundwater samples from water supply wells and monitoring wells.

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Initials				

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) provides guidance for Environmental Services Program (ESP) personnel when collecting groundwater samples from water supply wells and groundwater monitoring wells. There are many variables involved in the collection of a groundwater sample. Not only is there a variety of equipment that may be used to collect groundwater samples, but there are alternative procedures that may be followed in order to evacuate or purge stagnant water from a well prior to sample collection. The procedures described in this SOP will help the sample collector determine which type of equipment and evacuation/sampling techniques may be the most appropriate for a particular sampling project. When ESP staff are collecting groundwater samples at a sanitary landfill at the request of the Solid Waste Management Program (SWMP), staff should also consider the guidance described in the SWMP Technical Bulletin entitled *Collection, Handling, and Reporting Procedures for Groundwater Samples.*

Groundwater samples are often tainted with trace quantities of contaminants. When dealing with trace quantities, it is relatively easy for the sample collector to affect or bias a sample through cross contamination, absorption, agitation, aeration, etc. The goal of the sample collector is to reduce or eliminate sampling bias and collect a representative groundwater sample.

2.0 SUMMARY OF METHOD

The collection of a representative groundwater sample includes three basic elements - selection of equipment, selection of evacuation methodology, and finally the sample collection itself. The procedure section of this SOP (Section 6.0) covers these three basic elements.

3.0 HEALTH AND SAFETY

3.1 At a minimum, sampling personnel should wear steel-toed boots at all times while in the field. Although groundwater sampling is not an inherently dangerous activity, site specific conditions may present certain hazards. For any sampling investigation that occurs at a hazardous waste site, site specific health and safety requirements should be described in a written Health and Safety Plan (HASP). All ESP personnel who conduct work at hazardous waste sites will be required to participate in the department's medical monitoring program.

3.2 Groundwater samples may require chemical preservation (e.g., concentrated nitric acid). Sometimes chemical preservatives are added in the field, other times sample containers are pre-preserved. Sampling personnel should wear safety glasses and protective gloves when handling chemical preservatives or containers that are pre-preserved and should review applicable Material Safety Data Sheets for the chemicals that are being used.

3.3 Staff should be aware of the potential presence of venomous snakes, spiders, and stinging insects in the vicinity of well casings and well houses. Black widow spiders tend to live in dark secluded areas and may occasionally be found inside well casings. Wasp nests may be found in well casings and well houses. Venomous snakes such as copperheads may be encountered in many field settings. Field personnel should become familiar with the common venomous creatures that live in Missouri, be able to identify them, and learn how to avoid them in the field. Personnel should avoid using an insecticide spray to kill insects found next to a well due to the potential of contaminating the well with the spray. If a spray must be used, it should be documented in field notes in case the analytical results do indicate the presence of a contaminant in the sample.

4.0 PERSONNEL QUALIFICATIONS

All personnel involved in the collection of groundwater samples from wells should be familiar with ESP Standard Operating Procedures and should have been provided appropriate on-the-job training by experienced ESP personnel.

5.0 SUPPLIES AND EQUIPMENT

The items on the following list of supplies and equipment may not be needed for all groundwater sampling events. The list may also not be all inclusive, but is intended as a starting point for the ESP sample collector to consider when planning a groundwater sampling event.

- photoionization detector (PID)
- oil-water interface probe
- water level indicator
- plastic sheeting
- disposable bailers (PVC or Teflon)
- cord for lowering bailers into a well
- Grundfos pump and associated equipment
- peristaltic pump and associated equipment
- pH meter
- specific conductance meter
- decontamination supplies
- appropriate sample containers and preservatives
- cooler and ice
- sample labels
- GPS unit
- camera
- field notebook
- trip blanks
- analyte-free water for the collection of rinsate (equipment) blanks

- drums for storing contaminated purge water
- nitrile gloves and other appropriate personal protective equipment (PPE)
- filtration equipment (if dissolved metals are an issue)
- copies of applicable Standard Operating Procedures
- Chain-of-Custody Record

6.0 PROCEDURE

The procedures for collecting a groundwater sample from a water supply well are different from those used to sample a monitoring well. An active water supply well will have a dedicated submersible pump and, therefore, the selection of purging/sampling equipment will not be an issue since the existing dedicated pump can be used to purge and sample the well. Also, it is very difficult to use any down-hole measurement devices in a water supply well (e.g., a water level indicator) because the pump, drop pipe, and electrical wires form obstructions in the well. Water supply wells are often large diameter (minimum of 6") and deep and, therefore, have large well volumes. Monitoring wells, on the other hand, are not usually equipped with dedicated pumps and, thus, are open from top to bottom and allow for the use of down-hole measuring devices. Monitoring wells also tend to be small in diameter (often 2") and may be quite shallow, although deep monitoring wells are not uncommon.

When working around wells and collecting groundwater samples, it is important to maintain a clean working environment and reduce the potential for cross contamination. At a minimum, staff should always wear clean nitrile gloves when handling samples and sampling equipment. It is also good practice to spread clean plastic sheeting on the ground surrounding a well to create a clean working area where sampling equipment can be set down when not in use.

Proper decontamination of groundwater monitoring equipment is important to reduce the potential for cross contamination, especially when non-dedicated equipment is used. Ideally, groundwater purging and sampling equipment should be dedicated, but this is not always practical. The equipment used for taking in-situ field measurements (e.g., an interface probe or water level indicator) is typically non-dedicated and, therefore, must be decontaminated between wells. Some specific recommendations for decontamination are provided in the procedures described below. In addition, sampling personnel should review MDNR-FSS-206 *Decontamination Procedures for Sampling Equipment in the Field or Laboratory* for further guidance.

Field procedures should be documented in accordance with MDNR-FSS-004 *Field Documentation*. In addition to the guidance established in MDNR-FSS-004, it is recommended that the following items be documented in the sample collector's field notes:

- Type of well sampled (e.g., 2" PVC)
- Purge start and end times
- Well number and permit number, if applicable

- General conditions of well (e.g., unlocked casing, cracked pad)
- Well measurements (i.e., static water level, total depth)
- Field measurements (e.g., PID, interface probe results, pH, temperature, etc.)
- Type of equipment used to purge and sample well
- Pump rate
- Sample observations (e.g., color, turbidity)

6.1 Equipment Selection

For all wells that are not equipped with a dedicated pump (i.e., most monitoring wells), the ESP sample collector must provide the equipment necessary to purge and sample the groundwater. The following table summarizes the types of purging/sampling equipment readily available to ESP staff at the time this SOP was written.

Equipment	Advantages	Disadvantages
Disposable Bailers	• no need for decontaminaton • simple to operate and easy to carry • inexpensive • no depth limitations • available in different diameters and lengths	• labor intensive for deep wells or wells with a large volume of water • may cause increased turbidity when used for purging
Grundfos Pump (variable-speed impeller pump)	• high flow rate • able to pump from deep wells	• must be decontaminated between wells • relatively cumbersome to use and to carry • requires a power source
Peristaltic Pump	• easy to operate • no need for decontamination when disposable tubing is used	• limited to shallow wells, maximum lift ~ 25 feet • relatively low flow rate • not suitable when sampling for volatile organics • requires a power source

6.2 Field Screening/Field Measurements

6.2.1 If volatile organic contaminants are a concern, a PID can be used to screen the headspace of a well. High levels of volatile organics in the headspace of a well may be indicative of an LNAPL (light non-aqueous phase liquid) contaminant, such as gasoline. When a PID is used for screening, it should be done as soon as the well cap is being removed so any vapors that may be present do not dissipate before being detected.

A PID does not usually have to be decontaminated between wells since the instrument does not actually contact groundwater.

6.2.2 If either an LNAPL or a DNAPL (dense non-aqueous phase liquid) contaminant is suspected, then an oil-water interface probe should be used to make the field determination prior to purging or sampling a well. As previously mentioned, an oil-water interface probe can typically only be used in a well that does not have a dedicated pump. If an oil-water interface probe is used to screen a well, it should be used prior to well purging.

An oil-water interface probe must be decontaminated between wells to prevent cross contamination. The easiest method for decontaminating an oil-water interface probe is to clean it as it is being pulled from the well. At a minimum, as the tape is being pulled from the well, it should first be wiped off with paper towels that are soaked with a solution of Simple Green or, if unavailable, a solution of non-phosphate detergent. Next, the tape should be rinsed by wiping it with paper towels that have been soaked with clean, deionized or distilled water. The probe should also be decontaminated using Simple Green and/or soap followed by a deionized or distilled water rinse. If the interface probe and tape have been heavily contaminated through contact with an LNAPL or DNAPL, the equipment may need additional decontamination using scrub brushes and more Simple Green and soap and water.

6.2.3 Except for active water supply wells, it will be necessary to calculate the volume of water in a well in order to determine how much water must be purged prior to collecting a sample. Because an active water supply well is constantly being used, the issue of purging stagnant water from a water supply well is moot. Calculating the water volume involves measuring the depth to the static water level (or the top of the water column), the total well depth, and the inside diameter of the well pipe. Both the static water level and total depth are measured with a water level indicator. The following formula can be used to calculate the quantity of water in a well:

$$\frac{(H)\,(3.14)\,(R)^2}{231} = V$$

Where: H is the height of the water column in inches
R is the radius of the well pipe in inches
3.14 is the mathematical constant "pi"
231 is the number of cubic inches in one gallon
V is the volume of water in the well in gallons

In addition, the following table provides the number of gallons per foot for selected well diameters:

Diameter of well in inches	Gallons per foot
1"	0.041
1.5"	0.092
2"	0.163
2.5"	0.255
3"	0.367
4"	0.653
6"	1.469

Example:

A well has an inside diameter of 4 inches. The depth to static water level is 31.6 feet. The total depth is 42.4 feet. What is the well volume?
H is 42.4 - 31.6 = 10.8 feet x 12 inches = 129.6 inches
R is 2 inches

Then by using the formula, the answer is:

$$\frac{(129.6)\ (3.14)\ (2)^2}{231} = 7.05 \text{ gallons}$$

Or, by using the table above, the answer is the same:

10.8 feet x 0.653 = 7.05 gallons

The water level indicator must be decontaminated between wells using the same procedure described for the interface probe in section 6.2.2.

6.3 Well Purging

6.3.1 After determining the well volume, the well should be purged to remove the stagnant water in the well prior to sampling. This is important since stagnant well water has been exposed to ambient air, temperature changes, well casing materials, insects, and other outside influences that can bias the water sample.

6.3.2 For a well that recovers quickly (a high-yield well), there are three generally accepted procedures. Some references recommend that three well volumes be purged prior to sampling. Other references recommend that field parameters (e.g. ph, conductivity, and temperature) should be measured after each well

volume is removed. The well is ready to sample when the three field parameters have stabilized over two successive measurements (pH within 0.2 meter reading, conductivity and temperature within 10%). Refer to MDNR-FSS-100 *Field Analysis of Water Samples for pH,* MDNR-FSS-101 *Field Measurement of Water Temperature,* and MDNR-FSS-102 *Field Measurement of Specific Conductance* for procedures to follow when measuring field parameters. A third procedure, called micropurging, involves purging a well using low-flow techniques and collecting a sample after field parameters have stabilized. Refer to EPA/540/S-95/504 *Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures* for more information on micropurging techniques. Regardless of which method is used for well purging, a high-yield well should be sampled as soon as possible after purging is completed.

6.3.3 For a well that recovers slowly (a low-yield well), the well can be evacuated to dryness and sampled as soon as there is sufficient volume in the well for the parameters needed. If the well does not sufficiently recover within 24 hours, it is usually recorded as "dry" and not sampled.

6.3.4 The fate of purged water is determined on a site-specific basis and should be covered in a site specific sampling plan. Many sites have existing department-approved procedures for handling purge water that will include treatment at either an on-site treatment plant or at a public-owned wastewater treatment plant. Disposal of purge water at some sites may be handled under a valid land application permit. Purge water should not be poured onto the ground unless there is a valid land application permit. In some cases, field staff may need to containerize the purge water on-site and have samples of the purge water analyzed to determine the best method for disposal. If available, historical well data may be helpful in making a disposal determination. Purged water should never be discharged directly into a surface stream or well.

6.4 Sample Collection

6.4.1 Generally, a groundwater sample will be collected using the same equipment that was used to purge the well. However, it may be beneficial or necessary to use other equipment for sample collection. For example, a peristaltic pump may be used to purge a well in preparation to collect a sample for volatile organic analysis. Yet, because a peristaltic pump is not recommended for volatile organics, a disposable bailer may be used to collect the sample. For further guidance in collecting groundwater samples for volatile organics analysis, refer to MDNR-FSS-006A *Sampling Water and Other Liquids for Volatile Organic Analysis (VOA).*

6.4.2 Samples should be collected in order of volatilization sensitivity. The purpose is to reduce the agitation and aeration of the sample by slowly and carefully collecting the most volatile compounds first. In the *RCRA Groundwater*

Monitoring Technical Enforcement Guidance Document, the USEPA recommends the following order of collection for some common parameters:

- Volatile organics (VOA)
- Total organic halogens (TOX)
- Total organic carbon (TOC)
- Extractable organics (BNAs, pesticides, herbicides, PCBs)
- Total metals
- Dissolved metals
- Cyanide
- Sulfate and chloride
- Nitrate and ammonia
- Radionuclides

6.4.3 Non-dedicated sampling equipment must be thoroughly decontaminated between wells to prevent cross contamination. Equipment blanks should be collected when using non-dedicated equipment to prove the decontamination procedures are adequate. See MDNR-FSS-206 *Decontamination Procedures for Sampling Equipment in the Field or Laboratory* for decontamination protocol and MDNR-FSS-210 *Quality Assurance/Quality Control for Environmental Data Collection* for guidance in collecting equipment blanks.

6.4.4 Disposal of investigation derived wastes (IDW) such as purged groundwater, disposable sampling equipment, or PPE should be covered under a site specific sampling plan. If prior arrangements have been made, it may be appropriate to leave IDW on site for the property owner or operator to handle. In other cases, ESP staff may need to bring IDW back to the ESP for proper disposal.

6.4.5 For selection of proper sampling containers, preservation methods, and requirements for collecting trip blanks, refer to MDNR-FSS-001 *Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations.* At a minimum, water samples should always be placed in a cooler on ice immediately after collection.

6.4.6 If water samples are collected from a water supply well (i.e. private residence or municipal well) the samples should be collected at a point in the distribution system nearest the well head. The pump house will often have a tap available for sample collection. It is always preferable to collect a sample prior to any water treatment (i.e. softener, filtration, etc.) that may be part of the system. The collector should document in a field notebook pertinent information about the sample (e.g., color, turbidity, odors, etc.) and specifically describe the procedure used to collect the sample. The tap should be opened up and allowed to flow for three to five minutes prior to sample collection in order to purge any stagnant water that may exist in the pipes. Following the purging

procedure, the flow from the tap should be reduced for sample collection in order to minimize agitation and aeration. The sample collector should be aware that water supply wells are typically outfitted with a submersible pump that cannot be adjusted in terms of its impeller speed. A high-speed impeller may affect the water sample via excessive agitation and aeration.

7.0 REFERENCES

- American Society for Testing and Materials (ASTM), D 4448-85a, *Standard Guide for Sampling Groundwater Monitoring Wells*
- MDNR-FSS-001 *Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations*
- MDNR-FSS-002 *Field Sheet and Chain-of-Custody Record*
- MDNR-FSS-003 *Sample Numbering and Labeling*
- MDNR-FSS-004 *Field Documentation*
- MDNR-FSS-006A *Sampling Water and Other Liquids for Volatile Organic Analysis (VOA)*
- MDNR-FSS-018 *Sample Handling: Field Handling, Transportation, and Delivery to the ESP Lab*
- MDNR-FSS-100 *Field Analysis of Water Samples for pH*
- MDNR-FSS-101 *Field Measurement of Water Temperature*
- MDNR-FSS-102 *Field Analysis of Specific Conductance*
- MDNR-FSS-206 *Decontamination Procedures for Sampling Equipment in the Field or Laboratory*
- MDNR-FSS-210 *Quality Assurance/Quality Control for Environmental Data Collection*
- MDNR Solid Waste Management Program Technical Bulletin, 1999, *Collection, Handling, and Reporting Procedures for Groundwater Samples*
- U.S. Environmental Protection Agency, Office of Research and Development, Office of Solid Waste and Emergency Response, EPA/540/S-95/504, 1996, *Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures*

- U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, 1992, *RCRA Ground Water Monitoring: Draft Technical Guidance*

- U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, 1986, *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*